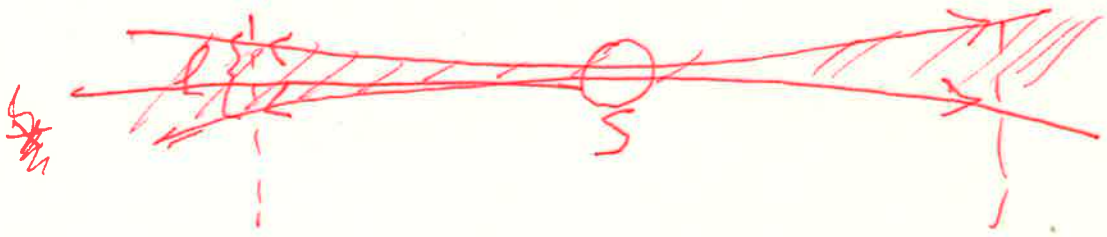
Dear Sir Karl,

Thank you for sending me the details of your very interesting thought experiment. Let me say at once that my ~~critical~~ initial reaction when we discussed it on the telephone, that decorrelation effects which arise as the particles separate in the original version of the EPR argument (which were overlooked by Einstein, although ~~printed~~ pointed out in unpublished work by Epstein ~~Einstein~~ -see also my paper Experimental Tests of the Sum Rule p.16, para 1 for discussion of this point and an estimate of the decorrelation as a function of the distance of the detector from the source) would perhaps spoil your argument is not correct, and, as you pointed out, such effects can be controlled by decreasing the distance between source and screen in your example (or equivalently by increasing the velocities of the particles at right angles to the screen). There are, however, other difficulties that occur to me. You are not explicit about the wave function you are assuming for the outgoing particles, except that the transverse positions q_{xA} ~~qx A~~ and q_{xB} ~~qxB~~ are strongly correlated. Let us examine two cases in detail -

Footnote ( )

1. Suppose first that the correlation between q_{xA} and q_{xB} arises since both are sharply correlated with a fixed location for the source. So the dependence of the total wave function on the transverse components ~~if~~ of position would be something like $\delta(q_{xA} - h) \cdot \delta(q_{xB} - h)$ where h is the precise transverse location of ~~its~~ the source. We know then that $q_{xA} = q_{xB} = h$ initially. As the particles separate the two δ-functions "diffuse" so the appearance of the two beams look like this



Screen A Screen B

* Footnote.

At the locations of screen A and screen B the decorrelation is such that precise measurement of qxB only identifies qxA to a range of order ℓ, where ℓ is the width of the beam of A particles where it reaches screen A. The resulting scatter at A would be of order $\hbar/\ell$.

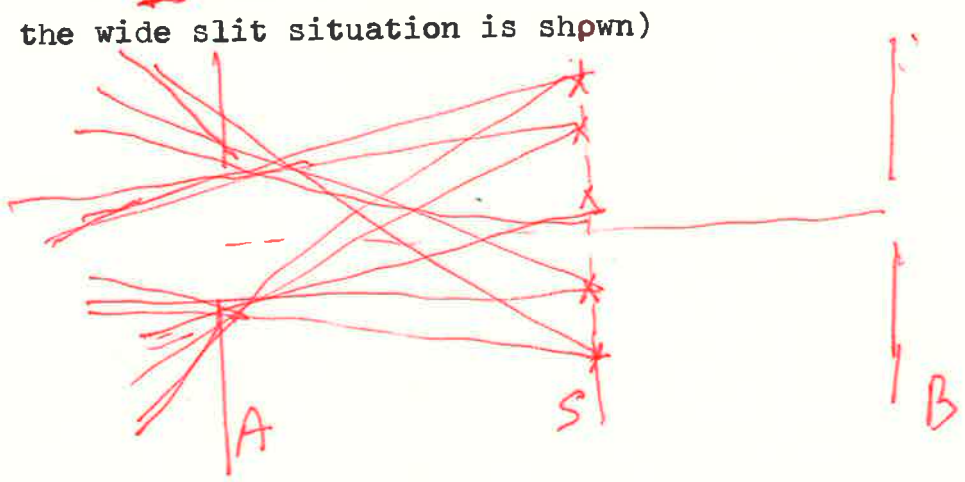
Suppose we start with two very narrow slits of width $d \ll \ell$ at A and B. We get scatters of order $\hbar/d$. As slit A is opened, the scatter at A will decrease until $d \sim \ell$, to the value $\hbar/\ell$ predicted by Copenhagenists as a result of the slit at B still being very narrow, but further widening of slit A will not produce any further decrease in scatter which is now controlled by the ' intrinsic ' de Broglie dispersion in the beam. In other words the predictions of QM and the Copenhagenists are exactly the same in respect of the variation in scatter behind slit B as B is widened.

The argument does not depend on the existence of decorrelation, i.e. it still applies if the A and B screens are moved close in to S. The ~~source~~ origin of the scatter in momentum behind the wide slit is just the range of transverse momenta required to achieve the 'narrow' initial beam at S. *

2) Suppose the wave function at S in respect of the x-coordinates of the two particles is an EPR one, i.e. an eigenstate of qxA - qxB and of PxA + PxB. The situation now is quite different from case 1 since qxA and qXb separately no longer have sharp values. The scattering of such an EPR state by the two slits can now easily be shown to correspond to a continuous line of 'incoherent' sources disposed parallel

* Footnote: In fact one can show that the range of transverse momenta in the beam remains of order $\hbar/\ell_{min}$, where ℓ_{min} is the minimum width, as the beam spreads. Since $\hbar/\ell_{min} > \hbar/\ell$ this fact is quite consistent with the uncertainty inequalities.

to the two screens. We now get large scattering for slit A narrow or wide arising as sketched in the diagram below (where the wide slit situation is shown)



Again the Copenhagen prediction of large scatter for a wide slit at A is also what QM predicts. The range of directions behind the slit in A now arises not because of diffraction effects but because of the range of directions for the incoming particles, i.e. once again from the range in pxA which is a feature of the EPR state (corresponding to the fact that qxA is not sharp, only qxA-qxB).
Notice in particular the difference from the scattering of a plane wave by a wide slit

The absence of scatter here is due to coherence in the lateral dimension of the beam, the feature which is absent in the EPR

state due to the fact that it is achieved by superimposing product states. (For example in the ~~Bohr~~ Bohm spin example $\frac{1}{\sqrt{2}}(\alpha(1)\beta(2)-\alpha(2)\beta(1))$ is incoherent as compared with $\frac{1}{\sqrt{2}}(\alpha(1)-\beta(1))$ in respect of measurements done on particle (1)).

So in neither of these two cases does the Copenhagen interpretation predict anything differently from QM (and hence presumably from experiment).

Finally there are general ~~points~~ proofs in the literature that the statistics of any measurements on A cannot be affected by what measurements are done on B in the EPR situation. The most recent using ~~if~~ Ghirardi, Rimini and Weber, Lettere al Nuovo Cimento 27 (1980), 293.

I would be interested to hear your reactions to these comments. I have not had time to ~~look~~ work through the paper by Ulrich Hoyer. I will write to you later about this.

With best wishes,

Yours sincerely

PS Sorry I could not ring you on Tuesday evening - my car broke down and I did not get home until ~~1~~ am! I hope you have a nice time in Austria.

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